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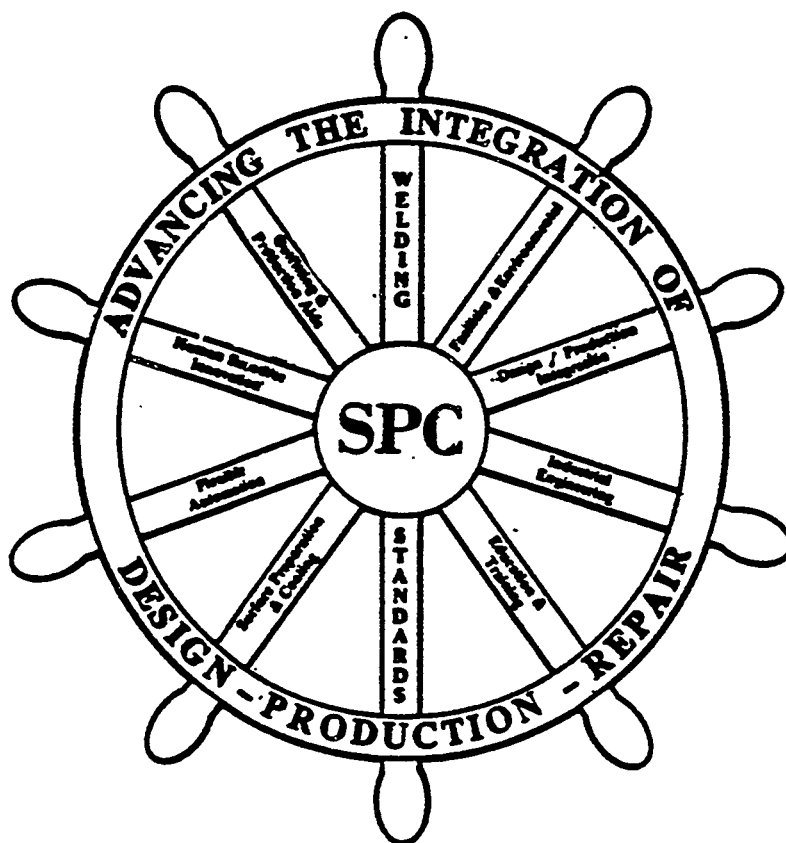
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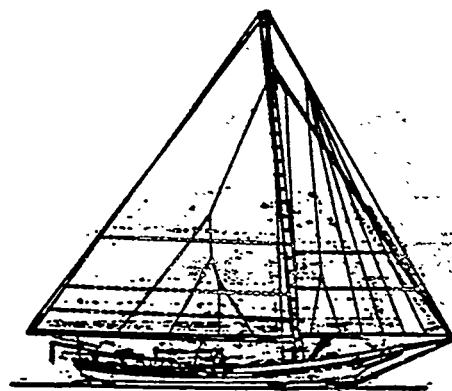
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Strategizing and Executing the Implementation and Utilization of Zone Technology at Philadelphia Naval Shipyard

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ABSTRACT

The fundamental philosophies of Group Technology or Zone Logic Technology are accepted practices in Japanese Shipyards. The ideologies, originally conceived in the U.S. ironically, were considerably refined by the Japanese Shipbuilding and Repair Industry and since 1978, have been reimported to the U.S. The traditional system-by-system approach to work has been replaced by a zone oriented product work breakdown structure, Zone Logic Technology. This grouping of jobs if executed properly, has the potential to significantly enhance efficiency and productivity.

Numerous documented articles published by the National Shipbuilding Research Program (NSRP) and the Society of Naval Architects and Marine Engineers (SNAME) have explained in detail how the U.S. time-honored shipbuilding methods (post WWII) are slowly being replaced by the more efficient and analytical procedures of Zone Logic Technology. These concepts dictate that work be planned and executed under a priority scheme:

- 1) Divide work into geographical zones carefully considering the nature of the problems that are involved,
- 2) Develop a zone oriented product and interim product work breakdown structure,
- 3) Properly sequence the work to be accomplished by stage and area,
- 4) Plan final systems tests as necessary.

To date, the application of Zone Logic Technology in new ship construction is commonplace. On the other hand, its use in the ship repair, overhaul and conversion environment has been relatively small in scope and isolated in application in both private and public shipyards.

However, the application at the Philadelphia Naval Shipyard (PNSY) has greatly overshadowed all other U.S. shipyards' efforts combined. PNSY started its implementation of Zone Logic Technology in the late fall of 1986, targeting the Service Life Extension Program (SLEP) for the USS KITTY HAWK (CV-63) for its initial application.

This paper will discuss the strategy in the development and implementation of Zone Logic Technology at PNSY. Frank disclosure of the valuable lessons learned and current status will also be presented. Equally as important is what the future has in store for Zone Logic Technology at PNSY, which will also be described.

This paper provides a candid presentation of the experiences in the implementation of Zone Logic Technology in a demanding repair environment.

INTRODUCTION

PNSY is nearly half way through the 37 month USS KITTY HAWK SLEP. After approximately 30 years of operational service, a SLEP is expected to add 15 years to a carrier's life, Ref.1. It is this project that enticed Senior Shipyard Management to consider Zone Logic Technology (ZLT).

The implementation strategy developed as a result of Shipyard Management taking bold innovative steps to accomplish the Hull Expansion Project planning for the USS Kitty Hawk. Though this project was eventually canceled, the planning effort was so intricately woven into the overall SLEP project that it gave rise to alternate implementations of ZLT at PNSY. In scope, the Zone Logic Technology application on USS KITTY

HAWK encompasses approximately one-third (over 400,000 mandays) of the total production effort, three years of work, and involves over half of the ship's compartments.

A game plan was devised after having had visited several shipyards worldwide (Japan, US, Canada and Europe) to investigate any prospective productivity enhancements that would help PNSY meet the immediate short term requirement of the Hull Expansion Project.

The ultimate goal was to improve our overall productivity to meet the Navy's operational fleet repair and conversion requirements. As a consequence, PNSY entered into a contract with Ishikawajima-Harima Heavy Industries (IHI) co., Ltd., Japan, in January of 1987 to assist the shipyard in implementing Zone Logic Technology. Just twelve months prior to the start of the SLEP project with the planning processes well underway, the decision was made to implement ZLT.

In view of this, the implementation procedure necessitated the use of several products from the traditional planning processes (such

as Job Order Progress Cards), and then adapt these products to ZLT. The system orientated outputs were reduced and re-assembled into Product Work Packages in the form of Unit Work Instructions (UWI). UWI's marked the departure from the traditional systems approach to planning work. This new method took various types of work in discrete areas and treated it as a work package in direct support of products and interim products as discussed in Ref. 2. This is a very important aspect of ZLT and worthy of reemphasis here.

A UWI is the compilation of all production work by phase of a particular discipline/trade intended in a specific location/subzone. This package included all support services. Further, a UWI could be a grouping of work for a unit/system/area which are inherent or unique to that item. The UWI's were then provided to the Production Department. The Data Based Management System designed to support the technical publishing process used in the development of Unit work Instructions is discussed in Ref. 2. The flow chart, represented here in Fig. 1, outlines the process from source documentation to final product.

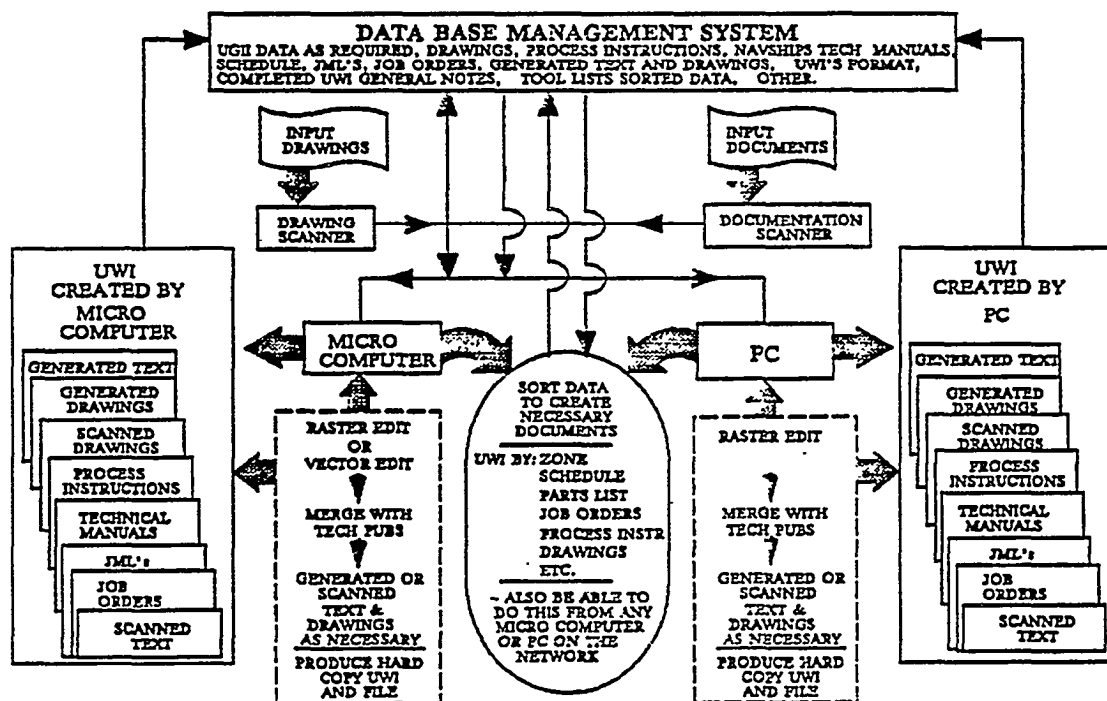


Fig. 1. ZLT System Process Requirements

The Production Department was re-organized to accomplish all zone work with a separate Zone Technology Production Group (see Fig. 2). This group drew its cadre from the existing Production Groups (i.e., structural, machinery, electrical, piping and service) to assemble nine Product Trades. These Product Trades were then organized into four Production Shops to perform the work.

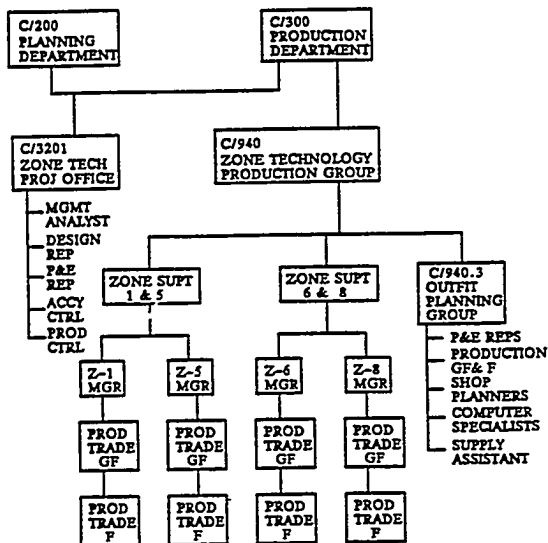


Fig. 2. ZONE LOGIC PROJECT TEAM

In a continuation of Ref. 2, this paper will consider two principal areas:

- 1) Detail the lessons learned during the USS KITTY HAWK SLEP, provide the current status, and outline the mid course corrections applied,
- 2) Describe the strategy intended for the continuation of ZLT applications at PNSY.

CURRENT STATUS OF ZONE LOGIC TECHNOLOGY IMPLEMENTATION

The broad scope of ZLT implementation at PNSY may best be broken down into three phases at this point:

- 1) Initial planning and the first year of execution in the USS KITTY HAWK SLEP, (Fall of 1986 - January 1989),
- 2) The planning phase for the USS CONSTELLATION SLEP and the final two years of execution of USS KITTY HAWK SLEP, (February 1989 - February 1991),
- 3) The execution of the USS CONSTELLATION SLEP in conjunction with other complex overhauls and other availabilities, (June 1990 - Future).

With the majority of planning complete, the USS KITTY HAWK was drydocked on November 25, 1987, though January 28, 1988, officially marked the start of her SLEP. Of the projected 1.2 million mandays to be completed during SLEP, the current physical progress is calculated to be 47%. Of the approximately 400,000 mandays to be accomplished by ZLT, over 230,000 have been completed (data date of 2 June 1989). Over the first 8 - 10 months of the project, a cost savings of approximately 1.8 million dollars was realized in the tank package alone. Although these preliminary results were encouraging, other developments within the shipyard in relation to ZLT were significantly impacting the overall potential for success. One alarming affect was the increasingly disharmonious working relationship developing between the Zone Technology Production Group and the Non-Zone Production Groups. The net result being a "Two Shipyard Syndrome". In conjunction with this was the growing appearance that anticipated productivity enhancements were not being realized. Consequently, in December 1988, the ZLT organization was changed to that reflected in Fig. 3. This action essentially dissolved the Zone Technology Group (Code 940) and reassigned the four shops (42, 44, 46 and 47) to the Structural Group Superintendent (Code 920).

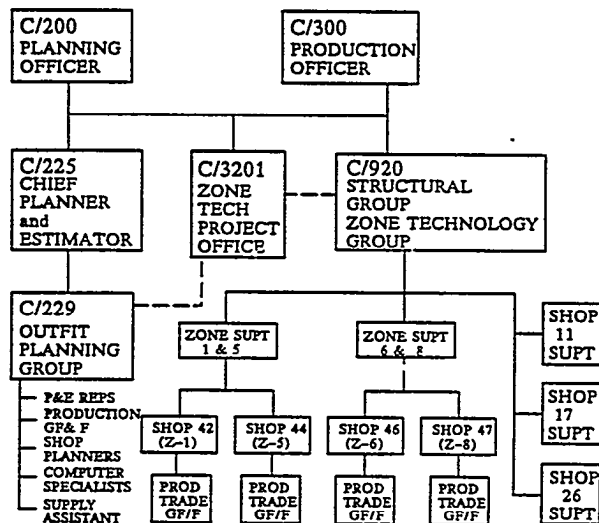


Fig. 3. CURRENT ZONE TECHNOLOGY ORGANIZATION

Further, the Outfit Planning Group (Code 940.3) was re-assigned as Code 229 to the Planning and Estimating Division, although remaining in the same location and performing the same function. The Zone Technology Project Office was not affected.

The Basis For Using A Group Approach
To Problem Solving (GAPS)

The existence of a problem between zone and non-zone oriented employees became particularly apparent late in 1988. The Shipyard Commander took the first step by dissolving the Code 940 group. Then, recognizing the need to clearly identify the hurdles preventing PNSY's ZLT efforts from succeeding as planned and define positive action to eliminate them, he directed that a GAPS team be assembled. The team consisted of select personnel associated with the planning and implementation of ZLT. The team was comprised of the following individuals:

<u>POSITION</u>	<u>CODE</u>
o Group Superintendent (Team Leader)	970
o Production Superintendent (Deputy Team Leader)	917
o Chief Planner and Estimator	225
o Assistant Repair Officer	331
o ZT Project Director	3201
o Zone Manager	944
o Zone Manager	942
o Supervisory Planner (Recorder)	970.03
o Head, Employee Division (Facilitator)	180

GAPS is a unique problem identification and resolving, and process improvement study.

For obvious reasons, it is initiated by managers. Though its approach is tailored to suit the intended purpose, it is also staged in way of problem/process discussion, brainstorming, cause and effect diagramming (fishboning), parieto diagramming, the gathering of information and/or data and the effective compilation of same for accurate analysis of the findings. Further, it addresses the implementation of positive corrective action and finally as a follow-up measure, the provision of a plan to monitor the improvements instituted. A GAPS team is expected to maintain the initiating authority attuned to their activities by way of regular project team meeting reports. The culminating activity of this GAPS team was a formal presentation of findings to the Shipyard Commander and members of his executive staff.

Over a period of four months the group met and conducted a series of interviews and surveys to investigate the implementation of ZLT. Initially, there were personal interviews conducted by the Team Leader and Deputy Team Leader. These were followed by other interviews with the entire GAPS Team with such personnel as ZLT Production Superintendents, Ship Superintendents, and representatives from Material Receipt and Inspection, Combat Systems, Hull, Mechanical and Electrical testing and the Supply Department.

<p>I UNIT WORK INSTRUCTION ISSUES</p> <p>1) DO YOU LIKE THE UNIT WORK INSTRUCTIONS? YES <input type="checkbox"/> NO <input type="checkbox"/></p> <p>A) IF YOU DISLIKED THE UNIT WORK INSTRUCTIONS, DID YOU EVER INDICATE SO ON THE FEEDBACK SHEET? YES <input type="checkbox"/> NO <input type="checkbox"/></p> <p>B) IF YOU DISLIKED THE UNIT WORK INSTRUCTIONS, TO WHOM DID YOU BRING YOUR OBJECTIONS? YES <input type="checkbox"/> NO <input type="checkbox"/></p> <p>CO WORKER <input type="checkbox"/></p> <p>FOREMAN <input type="checkbox"/></p> <p>GENERAL FOREMAN <input type="checkbox"/></p> <p>ZONE SUPT <input type="checkbox"/></p> <p>GROUP SUPT <input type="checkbox"/></p> <p>OUTFIT PLANNING <input type="checkbox"/></p> <p>C) WHAT DIDN'T YOU LIKE ABOUT THE UNIT?</p> <p>CLARITY OF DRAWING <input type="checkbox"/></p> <p>JOB DESCRIPTION <input type="checkbox"/></p> <p>JOB REFERENCES <input type="checkbox"/></p> <p>INSUFFICIENT ALLOCATED FUNDS <input type="checkbox"/></p> <p>THE FACT THAT IT WAS ONLY A PLACE OF <input type="checkbox"/></p> <p>THE TOTAL SYSTEM PICTURE <input type="checkbox"/></p> <p>HOW YOU CHARGE PRODUCT TRADE/ASSIST <input type="checkbox"/></p> <p>TRADE BAB MATERIAL LIST <input type="checkbox"/></p> <p>II MISCHARGING/COST SCHEDULE AND CONTROL (C/SCS)</p> <p>1) DO YOU KNOW WHO IS RESPONSIBLE TO CHARGE/TRACK ASSIST MANHOURS ON A UNIT? <input type="checkbox"/></p> <p>2) PLEASE PUT A CHECK NEXT TO WHO YOU BELIEVE IS RESPONSIBLE TO ENSURE ACCURATE CHARGES FOR THE ASSIST WORK ON THE UNIT. YES <input type="checkbox"/> NO <input type="checkbox"/> OTHER <input type="checkbox"/></p> <p>ZONE MANAGER <input type="checkbox"/></p> <p>PRODUCT TRADE FOREMAN <input type="checkbox"/></p> <p>PRODUCT TRADE GENERAL FOREMAN <input type="checkbox"/></p> <p>LEAD MECHANIC <input type="checkbox"/></p> <p>3) HOW MANY HOURS OF COST SCHEDULE AND CONTROL (C/SCS) TRAINING HAVE YOU HAD? <input type="checkbox"/></p>	<p>4) TO WHAT DEGREE DO YOU FEEL THAT MISCHARGING IS OCCURRING IN ZONE TECH WORK? <input type="checkbox"/></p> <p>NONE <input type="checkbox"/></p> <p>MINOR <input type="checkbox"/></p> <p>MAJOR <input type="checkbox"/></p> <p>OUT OF CONTROL <input type="checkbox"/></p> <p>5) IF YOU FEEL THAT MISCHARGING IS OCCURRING, WHAT DO YOU ATTRIBUTE THIS TO? <input type="checkbox"/></p> <p>CONFUSED AS TO WHAT JOB TO CHARGE <input type="checkbox"/></p> <p>DID NOT HAVE ANOTHER JOB/UNIT TO CHARGE TO OTHER (SPECIFY) <input type="checkbox"/></p> <p>III SCHEDULE ISSUES</p> <p>1) TO WHAT DO YOU ATTRIBUTE THE MAJOR REASON FOR NOT KEEPING ON SCHEDULE? PRIORITIZE FROM 1 TO 8 <input type="checkbox"/></p> <p>WORKSITE AVAILABILITY <input type="checkbox"/></p> <p>LACK OF MATERIAL <input type="checkbox"/></p> <p>LACK OF MANING <input type="checkbox"/></p> <p>POOR SCHEDULE <input type="checkbox"/></p> <p>POOR QUALITY UNIT <input type="checkbox"/></p> <p>QUALITY OF MECHANICS <input type="checkbox"/></p> <p>TECHNICAL ISSUES <input type="checkbox"/></p> <p>POOR SUPERVISOR DIRECTION <input type="checkbox"/></p> <p>OTHER (SPECIFY) <input type="checkbox"/></p> <p>IV MATERIAL ISSUES</p> <p>1) TO WHAT DEGREE DO YOU FEEL THAT LACK OF MATERIAL IS CAUSING A PRODUCTION HOLDUP? <input type="checkbox"/></p> <p>NONE <input type="checkbox"/></p> <p>MINOR <input type="checkbox"/></p> <p>MAJOR <input type="checkbox"/></p> <p>OUT OF CONTROL <input type="checkbox"/></p> <p>V GENERAL COMMENTS</p> <p>1) PLEASE PROVIDE ANY GENERAL COMMENTS, BOTH GOOD AND BAD, THAT AFFECT YOUR PRODUCTIVE EFFORTS UNDER ZONE TECH, FEEL FREE TO USE THE BACK OF THIS QUESTIONNAIRE <input type="checkbox"/></p>
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Fig. 4. GAPS TEAM QUESTIONNAIRE

1 CONTRIBUTION TO PROBLEM SITUATION

COMMUNICATIONS

Lack of senior management input
Lack of ongoing communications
Limited senior management support
Lack of outside support

METHODS

Too big a work package
Scheduling process-4 months
Full workload forecast not available
Too rigid implementation

MANPOWER

Wrong personnel assignments
Lack of prior practical experience
Undistributed mandays
Lack of training for first line supervisors

II IMPORTANT TO CORRECT AT THIS STAGE

COMMUNICATIONS

Lack of senior management input
Lack of ongoing communications
Limited senior management support
Lack of outside support
Failure to follow game plan

METHODS

Improper sequencing of work
Full workload forecast not available
Scheduling process-4 months
Lack of accurate monitoring system
Failure to follow game plan

MANPOWER

Wrong personnel assignments
Lack of training for first line supervisors
Undistributed mandays
Lack of prior practical experience

III POSSIBILITY TO CORRECT IN SHORT ORDER

COMMUNICATIONS

Lack of senior management input
Limited senior management support
Lack of outside support
Lack of ongoing communications
Failure to follow game plan

METHODS

Full workload forecast not available
Scheduling process-4 months
Errors in ways and means of charging
Too rigid implementation
Deviations from established work plan

MANPOWER

Wrong personnel assignments
Undistributed mandays
Lack of training for first line supervisors

THE MAJOR CONTRIBUTOR TO THE PROBLEM SITUATION
UNANIMOUS CONCLUSION DRAWN: FAILURE TO PROVIDE FOR SENIOR MANAGEMENT INPUT.

Fig. 5. GAPS TEAM FINDING

Formal surveys were also conducted by the GAPS Team. The survey questionnaire (Fig. 4), was distributed to all First and Second Line Supervisors in the ZLT Production Group. The table in Fig. 5 summarizes the findings of the GAPS Team with the single largest contributor being the "failure to provide for senior management input".

(1.4%) with poor graphics (column B) and 11 (1.2%) with poor quality drawings (column C). Production personnel found 30 (3.2%) with poor graphics (column D) and they considered the written work instructions of 44 (4.8%) too vague (column E).

Since the effort to produce the UWI's was such a large part of the ZLT implementation procedure, a great deal of attention was focused on their acceptance and quality. Shown graphically, the UWI product was very good. However, much effort has been expended to attend to the recognized deficiencies.

Lessons Learned

In addition, a survey was conducted by the Outfit Planning Group (OPG). Responses were retrieved via feedback sheets that accompanied each UWI. Of the UWI's issued and completed, a random sample of 924 which represented approximately 20% of those held on file at that time, were assessed for this study. The results are presented in Fig. 6. Column A shows the number assessed. The Planners who wrote the UWI's found 13

Prior to addressing the lessons learned, it is important to pause and review the more salient points to appreciate the gravity of the monumental task faced by PNSY. The decision to implement ZLT on the USS KITTY HAWK SLEP was made just twelve months prior to a 1.2 million manday availability. Of this, 400,000 MD's were allocated for ZLT. In addition to the tremendous administrative task posed by this decision, much of the traditional planning processes were complete or not economically feasible to alter. The majority of the shipalt drawings were complete as was much of the scoping of authorized work. Consequently, the fundamental concepts of ZLT could not be strictly adhered to. Rather, many compromises had to be negotiated several of which were not necessarily in the best interest of ZLT. The application of the concept on the USS KITTY HAWK proved to be a valuable learning environment.

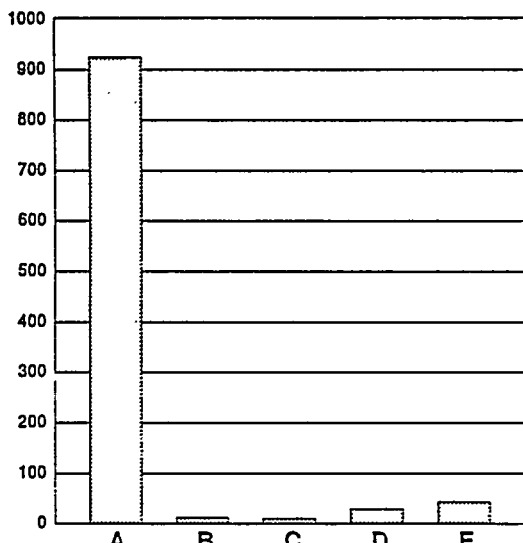


Fig. 6. COMPLETED UWI AUDIT

The following reflects a summary of the more important Lessons learned:

1) The Zone Technology Work Package was not initially networked into the overall ships scheduled network. As a result, Shipyard Management governing the availability had to refer to two sources of information to review the project's disposition. This meant administratively managing the project via two distinct parameters which was awkward at best, caused much confusion and was an additional burden. Ergo, it should be networked as soon as possible,

2) The ZLT work package was set up to work in four month windows. Only the work scheduled for that four month period was issued. Though this was not a popular decision and certainly not ideal, it was a necessary compromise. Four month schedules were used because there simply was not enough work available for issue to justify anything lengthier. In traditional fashion, the Planners and Estimators wrote job orders by phase and authorized work as the information was made available without requisite consideration given to all of the work to be accomplished in a zone/area. No guidance was provided them regarding the prioritization of this work. It should be appreciated that any one area could (and often did) have a number of Planners issuing work in it for a variety of different jobs which they progressed independently and in no delineated priority. As a consequence, the Outfit Planning Group found it extremely difficult if not altogether impossible to ascertain if absolutely all work in a particular zone, intermediate or subzone had been issued from P&E. There always existed an element of doubt. Ideally of course, all work would have been issued at the start of the availability. If that were the case, there would have been no doubt about adhering to the fundamental concepts of ZLT. But such was not the case and a schedule had to be provided to Production. Four month schedules (originally three month) were considered a reasonable compromise,

3) The unions representing the various trades and codes must be actively involved anti thoroughly supportive from the outset. This is important considering the novel Product Trade concept,

4) The cultural issues involving the people and personnel surrounding this effort were/are/will continue to be by far the most important concern of all. They must be dealt with from the outset to the maximum extent possible.

it should be obvious that the items noted above are not all unique to the implementation of ZLT.

FFUTURE APPLICATIONS OF ZONE TECHNOLOGY

Despite the concerns previously discussed, senior PNSY Management remain committed to the continuation of ZLT. A reflection of this commitment is exhibited in the decision to undertake the entire USS CONSTELLATION SLEP via ZLT. Major efforts are currently underway to analyze and apply the lessons learned from the USS KITTY HAWK throughout the pre-planning phases of the USS CONSTELLATION. A meticulous review of the processes required *is ongoing* and will result in their thorough clarification. These processes are being utilized in the planning for the Docking Selected Restricted Availability (DSRAJ of the USS SPRUANCE, DD 963, as well. It is the intent of Senior Management to test out these processes on the USS SPRUANCE as a precursor to the execution of USS CONSTELLATION SLEP. Although the manday package on the USS SPRUANCE is small, (approximately 11,000) exercising ZLT concepts on this project should prove invaluable in validating the entire PNSY process.

Integrated Strategies

The work of the Planning Department is thorough advanced planning in preparation for the customer, in this case Production. Chronologically then, this means that the zones and intermediate zones must be clearly defined and this information distributed as early in the planning process as possible. Secondly, it is necessary to accurately determine the scope of the work to be accomplished in each zone. Given this and the first cut (initial proposal) of the Production Schedule, the zones can be effectively prioritized. This first cut Production Schedule considers the area, work to be accomplished in it, identifies the most logical time frame (phase/sequence) to do it in (on a global sense) and how it is-proposed that this be done. This is an iterative process to be regularly reviewed and updated. Not to belabor the obvious but in a work environment of this magnitude, concurrent activity is expected.

This prioritization of zones and intermediate zones is then provided to the Supply, Design and Planning and Estimating Divisions for the sole purpose of positive and consistent guidance with respect to what aspects to pursue first. As an example, if

Supply had 10,000 Job Material Lists to process, the guidance would provide the approach to acquisition priorities driven by need dates to meet the Production Schedule. The same could be said of drawings from Design and of job orders from P&E. Herein marks one of the most significant departures from traditional shipyard management, that is "Integrated Planning for Production"!

In an attempt to address the issues identified above, a multi-tiered Zone Technology Steering Group was founded. The tiers are:

- 1) Senior Executive Zone Logic Technology Steering Group,
- 2) Zone Logic Technology Steering Committee,
- 3) Zone Logic Technology Steering Subcommittees.

The Senior Executive ZLT Steering Group, chaired by the Shipyard Commander, consists of the following individuals;

- Planning Officer
- Production Officer
- Chief Design Engineer
- All Production Group Superintendents
- Chief Planner and Estimator
- Chief Combat Systems Engineer
- Supply Officer
- Comptroller
- SLEP Project Officer
- Zone Technology Project Officer

This committee meets bi-weekly to discuss all aspects of ZLT implementation and planning. It is meant to monitor and discuss the overall progress in implementing ZLT, furnish a vehicle for important decisions when warranted, and provide guidance and direction to the other levels.

The ZLT Steering Committee is chaired by the Zone Technology Project Officer. It consists of division head level managers from various shops and codes across the shipyard management team. Its charter is to implement the second phase of ZLT. It assigns, oversees, and approves of the various subcommittees' activities involved in delineating the details of all aspects of ZLT implementation. This committee serves as the main conduit of information, administrative and strategic developments with respect to all issues involving ZLT.

ZLT Steering Subcommittees are chaired by designated steering committee members and consist of both members of the steering committee as

well as representatives from various trades and codes in the shipyard as required. There are currently three subcommittees:

- 1) integrated Strategy and Scheduling,
- 2) Material Support,
- 3) Training.

The flow chart (Fig. 7) reflects the completion of the first task of the Integrated Strategy and Scheduling (ISS) Subcommittee. Though initially generated for the CV SLEP Program, the availability strategy chart has been modified here significantly for the USS SPRUANCE. It shows the varied and complex interrelationships that exist in planning an availability. This may be considered as the simplified model of the SLEP version, which by virtue of sheer volume and complexity, would represent the most detailed of all availabilities.

The follow on task assigned to the ISS Subcommittee is to clearly define the implementation processes of a Master Schedule (center, Fig.7). The issue of a Master Schedule has been an integral part of the ship repair and conversion environment for some time. It is perhaps the singular most important aspect of an integrated repair/conversion strategy through the implementation of ZLT. As defined here, the Master Schedule draws the following schedules together in one data base.

- Drawing,
- Material Procurement Sequence,
- Test Development,
- Production,
- Tiger Team.

It should be emphasized that Master Schedule as used here is the culmination of many cycles in an iterative process beginning at the Proposed Planning and Production Strategy. (center, left Fig. 7).

The Material Subcommittee is responsible for delineating the Material Management System to support ZLT and specifically, the "kitting" effort planned for USS CONSTELLATION SLEP. Zone Technology has as one of its attributes, the fundamental requirement that a particular package of work be accomplished during a precise period of time, by a specific trade or product trade. Having this requirement, it is even more critical that an effective material management system be in place "and fully capable of supporting the work packages and schedule by providing all of the required material. The Material Subcommittee has reviewed the complete material support cycle from definition

This would support the development of detailed and accurate weekly schedules. The obvious consequence of this would be better schedule adherence, positive project management and equally as important, more desirable control of their work on behalf of the waterfront personnel.

Zone Technology In Design

Due to the time frame to implement ZLT on the USS KITTY HAWK, the Design Division Integrated Drawing Development effort was limited to two spaces; specifically, air conditioning machinery room number three and four and pump room number five.

The Design Team is fittingly called "Design for Production". Their mandate was to generate an integrated Design Work Package for each space, where practical, either by actual onboard shipchecks or by the use of Computer Aided Design (CAD) equipment. However, the actual method remains viable and is as outlined below:

- ° Shipcheck the compartments for systems that remain after shipalts are accomplished,
- ° Shipcheck for greater detail to support pre-fabrication accuracy,
- ° Develop composite drawings integrating new shipalt drawings with existing configurations,
- ° Perform interference checks,
- ° Review composite drawings for quality producibility for the purpose of pre-fabrication, pre-outfitting, providing detailed assemblies and conformance to standardizations.

CAD is a very dynamic method of accomplishing the same task. An example of a piping composite drawing for Pump Room number 5 as generated by CAD is shown in Fig. 8. This drawing is then supported by the requisite number of detailed drawings required for the actual system fabrication and assembly. On this particular work package alone, twenty Interference Control Memorandums were sent to various Design Codes highlighting interference problems. This number does not include the number of informal corrections initiated while working with the preliminary drawings. The benefits of CAD are:

- ° A detailed and accurate document to accomplish installation (easier/safer).
- ° Advanced production techniques eliminating interferences to a fine point of detail,
- ° provide consistent base line model supporting multiple Design Engineers to use and thus eliminating repetitive efforts,
- ° automated interference control eliminates guesswork and constant communication between Design Engineers,
- ° incorporates the most logical integrated installation configuration of all items within the space and supports ease of maintainability,
- ° accommodates computer interface with CAM for prefabrication and preoutfitting capabilities and accuracy of same,
- ° accurate computer model available for future availability advance planning efforts.

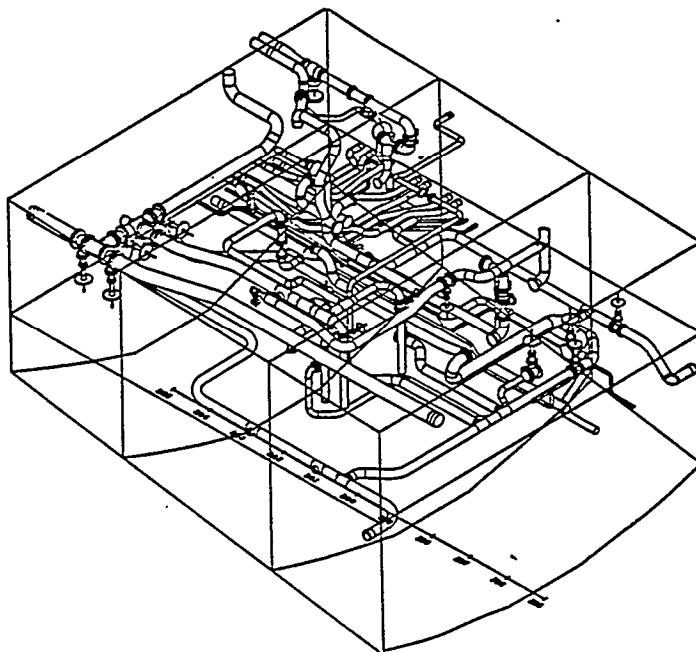


Fig. 8. PUMP ROOM PIRING COMPOSITE BY CAD

For the USS CONSTELLATION SLEP more than twenty-five complex compartments will have an Integrated Design Work Package. These may involve many of the extensive and complex ship alterations which include:

- ° Weapons Magazines,
- ° Catapult Accumulator Spaces,
- ° Rotary Retractable Machinery Spaces,
- ° Combat Information Center,
- ° Two Air Conditioning Machinery Spaces,
- ° All three Arresting Gear Engine Spaces,
- ° NSSMS Control Space,
- ° Two Radar Rooms and associated Pump Rooms,
- ° All five Pump Rooms.

Additionally, all drawings for the USS CONSTELLATION SLEP are being developed by intermediate zone. As discussed in Ref. 2, the entire ship is broken down by area/zone whereby these zones reflect the products and interim products required to complete the availability. These zones are then further broken down into intermediate zones and then again to sub-zones. The generic zone breakdown for the USS CONSTELLATION in Fig. 9 shows the intended Zone Manager responsibilities of Production, Design and P&E. An example of intermediate zone in zone 9 would be both forward catapults and a sub-zone might be #1 catapult. In addition, a potential cohesive advantage of grouping work by product and zone/area exists.

C/230 C/240	C/300
C/970	ZONE 0: SERVICES DOCK WORK AND MISCELLANEOUS
C/920	ZONE 1: ALL TANK WORK, (CLEANING, PAINTING, STRUCTURAL PIPING, TESTING) TANK TOPS AND HULL STRUCTURAL
C/930 & 960	ZONE 2: ALL WORK ASSOCIATED WITH SHAFT ALLEYS INCLUDES MAIN MACHINERY SPACES EXCEPT FOR TANK TOP STRUCTURAL REPAIRS
C/960	ZONE 3: ALL WORK ASSOCIATED WITH AUXILIARY MACHINERY SPACES (EXCEPT TANK TOP REPAIRS)
C/950	ZONE 4: ALL MAGAZINE WORK EXCEPT TANK TOP REPAIRS
C/930	ZONE 5: ALL PUMP ROOM WORK, EMERGENCY GENERATION, AC SPACES, RUDDER WORK
C/920	ZONE 6: SPACES FROM 3rd DECK TO MAIN DECK
C/930	ZONE 7: HANGAR BAY
C/950	ZONE 8: MAIN DECK TO FLIGHT DECK PLUS ISLAND
C/930 & 960	ZONE 9: FLIGHT DECK

Fig. 9. GENERAL CV-64 ZONE BREAKDOWN

Zone Logic Technology In Planning

As a natural succession to the intermediate zone drawing development, the P&E Division is producing all initial job scoping information by intermediate zone or sub-zone as applicable. Owing to the sheer size of an aircraft carrier, some areas present unique problems. For example, consider one of four main machinery

spaces as an intermediate zone (Fig. 9, zone 2). The volume of concentrated effort to be accomplished within a main machinery space during a SLEP is absolutely immense, and since there are no geographic boundaries to speak of in the space, it is not at all practical to further divide it into subzones. After all, the work is very nearly in every case entirely contained within that geographic area. Another example but not as complex is the hull blasting and painting sequence. It is treated as an intermediate zone of itself and is not divided into subzones. On the other hand, consider the catapults (four in number) which do spread out amongst a wide variety of compartments and geographic locations. In this case, the subdivision into subzones is imperative to the success of the work packaging and execution.

This is a significant departure from what was done on the USS KITTY HAWK SLEP in the sense that Unit Work Instructions were developed from the traditionally written system job orders. Now that scoped work data is available by area, the information can be collated (via automated data processing) by phase and area to be packaged for Production. These packages in many cases will be supported by the integrated Design Work Packages as previously described. Because of not being able to collect detailed work area information on USS KITTY HAWK, the UWI had to be developed. It required an enormous duplication of efforts to the degree outlined in Ref. 2. Efforts are now underway that will enable the Outfit Planning Group to package work as before without having to actually duplicate the traditional job orders. This should result in significant cost saving improvements in the processes used for the USS KITTY HAWK.

Realize that it is the Production Schedule that drives the integrated efforts of the Planners, Schedulers, Material Suppliers and Outfit Planning Group. After receiving the detailed job order from the P&E codes and ascertaining the scheduled start date of the work, the Outfit Planning Group will be required to liaise with the Material Suppliers to determine if all of the required material is available and properly kitted. If so, they then prepare and issue the work package to Production.

The OPG may be considered as the final check point of all planning efforts. Though the case described above is ideal, there may be exceptions to it. For example, perhaps there may be an item or two of

the material that is not yet available; it may or may not have an expected delivery date and it may or may not be a problem that the Shipyard can control; there may be a plan or a shipalt drawing that is not yet available. In these cases, the OPG will assess the whole of the work package and make a conscientious decision with respect to whether it is or is not issued without this particular aspect of the package. The Production Schedule would be affected and administrative action would have to be initiated to deal with the problem. They may decide not to issue the package which would also have direct ramifications on the Production Schedule. Therefore, they must take positive steps to fill the void with practical alternatives.

The intent is to maximize the most efficient flow of work to accommodate the established Production Schedule. The corollary being, minimize incomplete work packaging. However, this piece of information (the OPG not able to prepare/issue a work package for whatever reason) is particularly important as it provides a valuable impact analysis. That is, the impact on the Production Schedule caused by unavailable material; the impact (or snowball effect) of any one division not adhering to established need dates provided in the zone and intermediate zone prioritization; the impact on the ships availability by significant growth in the authorized work package.

Only achievable work packages will be issued the likes of which will include:

- ° Cover sheet,
- ° Verification sheet,

- ° All Keyops that support the event work package,
- ° All technical references (plans, drawings, cesc procedure: ana standards, etc.) required to accomplish the work instructions, Job material list at the Keyop level,
- ° Work completion verification card,
- ° Customer feedback sheet.

Zone Technology In Production

The Work is then in the hands of Production. It is imperative that they execute the plans explicitly in strict adherence to the schedule. Common sense must still prevail and constructive feedback must be strongly encouraged if not altogether demanded to continually strive to improve upon the quality of the process.

The lessons learned from the USS KITTY HAWK SLEP precipitated the changes in the Production Department organization as detailed previously. As expected, the results of the surveys conducted through GAPS indicated the unanimous approval of the Product Trade concept. First Line Supervisors found this extremely beneficial in developing an efficient work flow. To enhance this process during future availabilities yet maintain parent shop identity, modifications will be made to the Production organization. That proposed for the USS CONSTELLATION SLEP is shown in Fig. 10. As indicated, there will be Zone Managers who will have production responsibilities for a zone and will report directly to their respective Group Superintendant. There will also be SLEP Superintendents who will report to Group Superintendents and will provide a direct interface between zones.

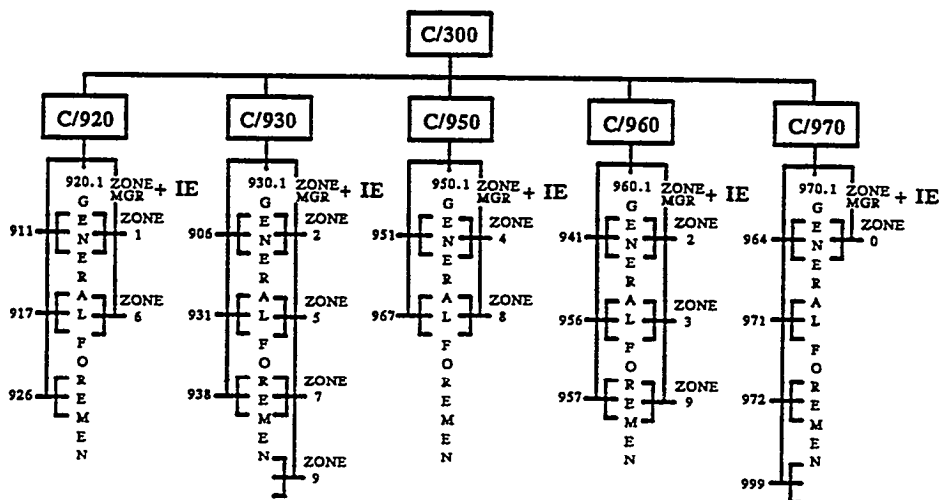


Fig. 10. PNSY PRODUCTION DEPARTMENT

By identifying work by area; producing drawings by area; preparing work packages by area; scheduling by area, and accomplishing work by area, the cohesive potential is again gainfully exploited to improve productivity, that is "Integrated Planning for Production".

Finally the involvement of Industrial Engineers in the daily Production Management team organization is planned to further foster the objectives of Zone Managers. The immediate benefit will be the detailed evaluation of all work processes. More importantly though, will be the direct interface (feedback) with other support codes such as Scheduling, Design, Testing, P&E and OPG.

Summary

The concepts of ZLT are being modestly applied to the USS KITTY HAWK SLEP with some administrative difficulties. In the past, these efforts were, in general, outside the traditional realm of shipyard organizational procedures. In subsequent availabilities and overhauls, ZLT will be applied much sooner in the planning process. The DSRA of the USS SPRUANCE is evidence of this and will prove to be the test case of all associated processes. The more important proposals are:

- ° Standardization of zone and intermediate zone principles applied to all classes of USN ships ultimately leading to standardization of zones and intermediate zones within each class of ship,
- ° Identify work by item in the work authorization document,
- ° Provide for electronic distribution of work instructions together with their supporting technical documentation (i.e. enhanced use of Automated Data Processing),
- ° Increased emphasis on the provision of and adherence to short term Detailed Production Schedules in direct support of the First Line Supervisors.

CONCLUSIONS

Much has been accomplished in the name of Zone Logic Technology at the Philadelphia Naval Shipyard. This paper has outlined the experiences and reactions to the problems encountered throughout this process. ZLT continues to be a part of the future at PNSY as the Senior Shipyard Executive Management are committed to its approach. They are convinced that ZLT is the vehicle to improve productivity. It has much to offer PNSY in the way of improving our quality and hence, our competitive edge. The motivation here is survival in an extremely competitive industrial environment by fundamentally changing the way we do business.

In general, the applications of ZLT are being infused into a greater part of the traditional shipyard organizations. As these organizations take on the new methods and procedures, it is essential that the fundamental precepts of Zone Logic Technology are maintained and used to guide the improvement efforts.

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